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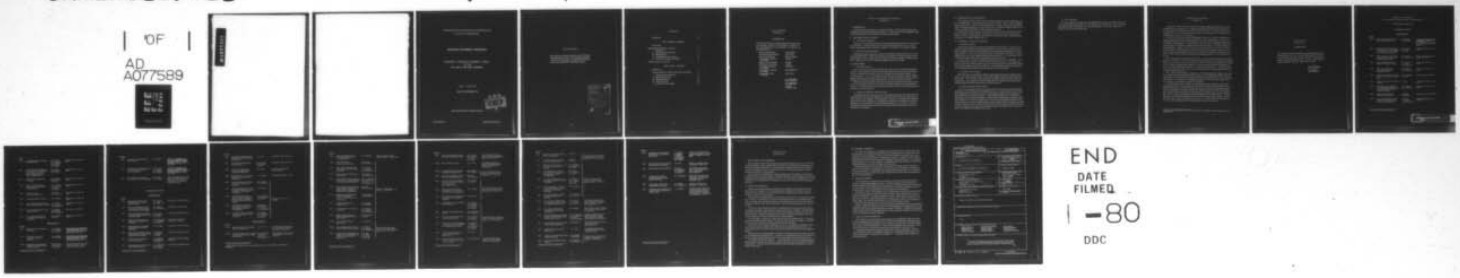

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

LINCOLN LABORATORY

ADVANCED ELECTRONIC TECHNOLOGY

QUARTERLY TECHNICAL SUMMARY REPORT
TO THE
AIR FORCE SYSTEMS COMMAND

1 MAY – 31 JULY 1979

ISSUED 25 SEPTEMBER 1979

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LEXINGTON MASSACHUSETTS

INTRODUCTION

This Quarterly Technical Summary covers the period 1 May through 31 July 1979. It consolidates the reports of Division 2 (Data Systems) and Division 8 (Solid State) on the Advanced Electronic Technology Program.

CONTENTS

DATA SYSTEMS
DIVISION 2

INTRODUCTION

This section of the report reviews progress during the period 1 May through 31 July 1979 on Data Systems. Separate reports describing other work of Division 2 are issued for the following programs:

Seismic Discrimination	ARPA/NMRO
Distributed Sensor Networks	ARPA/IPTO
Education Technology	Bureau of Mines
Network Speech Systems Technology	OSD-DCA
Digital Voice Processing	AF/ESD
JTIDS Speech Processing	AF/ESD
Packet Speech Systems Technology	ARPA/IPTO
Radar Signal Processing Technology	ARMY/BMDATC
Restructurable VLSI Technology	ARPA/IPTO

A. J. McLaughlin
Head, Division 2

A. V. Oppenheim
Associate Head

T. Bially
Associate Head

DIGITAL INTEGRATED CIRCUITS
GROUP 23

I. INTRODUCTION

An ECL serial/parallel converter was tested to 800 MHz. First experiments with a new 64K MNOS mask set showed improved performance. A new project in VLSI reconfigurable logic was started with work on an electrically alterable nonvolatile switch.

II. HIGH-SPEED DIGITAL CIRCUITS

A. Parallel/Serial Converter

Tests of the 8-bit parallel/serial converter have shown that it will operate at a serial output rate of 800 MHz. On these devices there is evidence that the speed is limited by excessive emitter-base leakage and that, with better transistors, operation to 1 GHz might be possible.

B. Poly-Ox Process Development

Measurements on packaged test transistors have yielded the expected peak f_T's of 3.5 GHz on a reproducible basis. Values of 4.0 GHz have been measured for similar transistors with a polysilicon base contact and hence less base-collector and collector-substrate junction capacitance. Masks have been made to implement polysilicon emitter processing.

III. MNOS MEMORY

A. 64K-Chip Fabrication

Several runs have been completed using the new mask set for the second-generation 64K memory. This redesign incorporates an active digit pulldown and p^+ word resistor pulldowns, as well as experiments to evaluate second-level decoding, an on-chip sense amplifier, and 0.1-mil capacitors. The 3 × 3 decoded test devices on bulk Si were found to operate properly. Revised masks are on order which will allow proper operation of the digit n-channel transistor pulldown on SOS and provide mask compensation for the 0.1-mil capacitor subsection.

Further experiments on mask materials for the damaged-silicon isolation process indicate that 2.0 μm of positive photoresist may be used to mask the Ne implant, thus simplifying the process. Very high resolution may be obtained if provision is made to prevent substantial wafer temperature rise during implant.

B. Polyimide Insulation for Multi-level Metal

Polyimide plastic insulation between first- and second-level metal on the 64K memory has been developed to the point of producing better than 95-percent short-free test devices where each device has 1000 crossings. This insulation is 0.8 μm thick. Following a 300°C bake plus normal positive resist development, the polyimide is plasma-etched resulting in excellent via definition, no spurious undercut, and nicely sloped sidewalls on 3- × 3-μm vias. A 70-Å insulating film remaining on the first-level metal must be removed chemically to achieve consistently low via resistance.

IV. RECONFIGURABLE LOGIC DEVICES

A new program has been started in Very Large Scale Integration, with an emphasis on electrical reconfiguration. By using electrically alterable switches, a system will be configured from the good cells on a chip, thereby giving tolerance for circuit defects and also the ability to construct different systems from a set of common cells. The system and design studies for this project are supported by DARPA and will be reported elsewhere.

One type of electrically alterable nonvolatile switch is an FET with a MNOS gate structure. With the addition of a single diffusion, it is possible to combine such an FET with an emitter follower to provide a programmable transmission switch with current gain. Experiments with this device were initiated during this quarter.

V. PROCESSING, TESTING, AND ANALYSIS

A. Deposition of Metals

A new vacuum deposition system has been installed and is operational. The system was designed to deposit aluminum and aluminum alloy films to meet a variety of applications. Particular emphasis was placed on minimizing hydrocarbon and sodium contamination of devices during deposition. As a result, the system includes a cryogenic high vacuum pump, a trapped roughing pump, and a planar magnetron sputter deposition source. Test results indicate that a significant reduction in both forms of contamination has been achieved.

A basic process for sputter depositing aluminum films has also been established. The major problem to be solved was excessive surface texture which caused a very cloudy appearance and could affect subsequent processing. The films were improved by preheating the wafers and associated tooling to 100°C before sputtering, and by pumping the system at its maximum rate during sputtering to minimize the partial pressure of water and oxygen.

B. Capacitance Test Programs

New hardware for the capacitance-voltage measurement system has been installed and is on-line. This allows computer control over the input amplifier gain and the range of the capacitance meter. The net result is better resolution in the applied voltage and in the capacitance measurement. Five programs are used for making different capacitance measurements and deriving material and device properties from the measurements.

C. Properties of Neon-Implanted Silicon

As part of a continuing review of the electronic properties of the neon-implanted damaged silicon that is used for isolation in the 64K MNOS memory, a calculation was carried out of the band bending and barriers that form between heavily damaged regions and the crystalline regions beyond the range of the neon implant. Assuming uniform doping, and a Gaussian tail of damage sites (traps), Poisson's equation was solved numerically through the damage tail region. It was found that, at least for tail widths greater than 0.35 μm (which should correspond to the range of interest), there is no significant space charge or built-in field in the damage-crystalline transition region at zero bias. This means that at least for forward bias and small reverse bias, the series resistance of the depleted heavily damaged regions will dominate the V-I characteristics and no significant rectification will be seen.

D. Laser Annealing

Use of an elliptical spot shape with a 10/1 length/width ratio has proven advantageous for laser crystallization of fine-grained (< 1-μm) polysilicon and LPCVD Si on a-SiO_2. Use of this spot shape has increased the grain size from approximately 13 × 13 μm for a round spot, to about 15 × 650 μm for the elliptical spot.

COMPUTER SYSTEMS
GROUP 28

As the quarter ended, the new Information International COMp80 plotting system was completing its factory acceptance test. A companion hardcopy processor has been delivered and is being installed. Development of the META interpreter software to provide essentially the same kind of service as the Datagraphix 4060 is also nearing completion. The transition to the COMp80 will be effected early next quarter.

Considerable work has been put into bringing up new releases of the time-sharing-system control program (VM/370 CP) and interactive monitor (CMS). Concurrently, a performance enhancement package licensed by IBM and known as the Basic System Extensions Program Product (BSEPP) is being installed. As with any major systems change, the additional unique Lincoln problem is to integrate local modifications into the standard code. Currently, 84 files of Lincoln updates are involved. Stated simply, the task is to merge the new releases of CP and CMS with BSEPP and local changes to provide users with a more reliable system which is upwards compatible, yields improved performance, and offers new functions. This work has consumed a major amount of system programmer time during this quarter and will continue into the next.

Other activities involved languages and libraries. A new version of the mathematical library IMSL has been installed. The APL batch-processing facility noted in the last Quarterly Technical Summary* has now been released for general use. Other APL features provided include APLGOL (a block-structured language superimposed on APL to facilitate structured programming practices), extensions to the graphics package, and a public workspace monitor. In parallel with the effort to provide PASCAL under CMS, the new DOD language ADA is being studied with the help of locally available interpreters.

For as long as the Laboratory has operated a central general-purpose computer, there have been requirements for interfacing nonstandard devices. The installed IBM 370/168 connects to such devices for the most part via the low-speed EIA RS232 compatible serial binary communications subsystem. Requirements for significantly higher data rates have been handled on an ad hoc basis as, for example, the Ramtek color displays.

Prompted by interest in the addition of more high-performance displays as well as other high-data-rate devices, an investigation of a high-speed data bus was made during this quarter. Broad functional requirements have been developed and a few commercial implementations reviewed for feasibility. The general approach is to establish, between the IBM 370/168 and the bus, an interface which behaves like a tape subsystem on the inboard side, but on the outboard side is free to function according to the unique capabilities of each attached device. Total system integrity is protected by established channel protocol, system software support is easily developed, and a variety of devices may be interfaced. It is expected that this study will lead to a more formal definition and initial implementation during the next quarter.

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*Quarterly Technical Summary, Advanced Electronic Technology, Lincoln Laboratory, M.I.T. (15 May 1979).

SOLID STATE
DIVISION 8

INTRODUCTION

This section of the report summarizes progress during the period 1 May through 31 July 1979. The Solid State Research Report for the same period describes the work of Division 8 in more detail. Funding is primarily provided by the Air Force, with additional support provided by the Army, ARPA, NSF, and DOE.

A. L. McWhorter
Head, Division 8

I. Melngailis
Associate Head

DIVISION 8 REPORTS
ON ADVANCED ELECTRONIC TECHNOLOGY

15 May through 15 August 1979

PUBLISHED REPORTS

Journal Articles

JA No.			
4853	High Resolution Double Resonance Spectroscopy of SF_6	P. F. Moulton A. Mooradian	In Laser Induced Processes in Molecules, edited by K. L. Kompa and S. D. Smith (Springer-Verlag, New York, 1979), p. 37
4872	Wavenumbers, Line Strengths, and Assignments in the Doppler-Limited Spectrum of Formaldehyde from 2700 to 3000 cm^{-1}	L. R. Brown* R. H. Hunt* A. S. Pine	J. Mol. Spectrosc. 75, 406 (1979)
4877	Energy Extraction from Metastable Excimers – Hg_2 as an Energy Storage Medium	D. J. Ehrlich R. M. Osgood, Jr.	IEEE J. Quantum Electron. QE-15, 301 (1979)
4886	Spectral Intensities in the ν_3 Bands of $^{12}CH_4$ and $^{13}CH_4$	M. Dang-Nhu* A. S. Pine A. G. Robiette*	J. Mol. Spectrosc. 77, 57 (1979)
4891	Alkali-Metal Resonance-Line Lasers Based on Photodissociation	D. J. Ehrlich R. M. Osgood, Jr.	Appl. Phys. Lett. 34, 655 (1979)
4897	Linear Scan Control of Tunable Lasers Using a Scanning Fabry-Perot	M. J. Coulombe A. S. Pine	Appl. Opt. 18, 1505 (1979)
4901	Synthesis and Crystal Growth of $CdGeP_2$	P. Vohl	J. Electron. Mater. 8, 517 (1979)
4902	Anomalous Noise Behavior in Wide-Bandwidth Photodiodes in Heterodyne and Background-Limited Operation	D. L. Spears R. H. Kingston	Appl. Phys. Lett. 34, 589 (1979)
4906	Higher-Order Nonlinear Processes in $CdGeAs_2$	H. Kildal G. W. Iseler	Phys. Rev. B 19, 5218 (1979)
4913	Laser Emission Study of the Pressure Dependence of the Energy Gap in Tellurium	A. S. Pine N. Menyuk G. Dresselhaus*	Solid State Commun. 31, 187 (1979)

*Author not at Lincoln Laboratory.

JA No.			
4920	Ion-Implanted Laser-Annealed GaAs Solar Cells	J. C. C. Fan R. L. Chapman J. P. Donnelly G. W. Turner C. O. Bozler	Appl. Phys. Lett. 34, 780 (1979)
4930	Crystallographic Orientation of Silicon on an Amorphous Substrate Using an Artificial Surface-Relief Grating and Laser Crystallization	M. W. Geis D. C. Flanders H. I. Smith	Appl. Phys. Lett. 35, 71 (1979)
4931	A SAW/CCD Accumulating Correlator	D. L. Smythe R. W. Ralston E. Stern	Appl. Phys. Lett. 34, 620 (1979)
4933	Planar Guarded Avalanche Diodes in InP Fabricated by Ion Implantation	J. P. Donnelly C. A. Armiento V. Diadiuk S. H. Groves	Appl. Phys. Lett. 35, 74 (1979)
4936	FM Mode-Locked $Nd_{0.5}La_{0.5}P_5O_{14}$ Laser	S. R. Chinn W. K. Zwicker*	Appl. Phys. Lett. 34, 847 (1979)
4937	Electroabsorption in GaInAsP	R. H. Kingston	Appl. Phys. Lett. 34, 744 (1979)
4946	Laser Photodeposition of Metal Films with Microscopic Features	T. F. Deutsch D. J. Ehrlich R. M. Osgood, Jr.	Appl. Phys. Lett. 35, 175 (1979)
4949	Ultraviolet Solid-State Ce:YLF Laser at 325 nm	D. J. Ehrlich P. F. Moulton R. M. Osgood, Jr.	Opt. Lett. 4, 184 (1979)
4962	Four-Wave Interactions in Acoustoelectric Integrating Correlators	R. W. Ralston E. Stern	Appl. Phys. Lett. 35, 150 (1979)

Meeting Speeches

MS No.			
4577	High Na^+-Ion Conductivity in $Na_5YSi_4O_{12}$	H. Y-P. Hong J. A. Kafalas M. L. Bayard	Proceedings of the 28th Power Sources Symposium (Electrochemical Society, Princeton, New Jersey, 1979), p. 1
4578	NASICON, A New Solid Electrolyte for Na/S Batteries	J. A. Kafalas H. Y-P. Hong	Proceedings of the 28th Power Sources Symposium (Electrochemical Society, Princeton, New Jersey, 1979), p. 2
4753A	Emission Cross Section and Flashlamp-Excited NdP_5O_{14} Laser at 1.32 μm	M. M. Choy* W. K. Zwicker* S. R. Chinn	Proc. Intl. Conf. on Lasers '78, Orlando, Florida, 11-15 December 1978, pp. 163-167

*Author not at Lincoln Laboratory.

MS No.			
4756	Properties of InP Doped with Fe, Cr or Co	G. W. Iseler	Chapter 2 in Gallium Arsenide and Related Compounds (St. Louis) 1978 (The Institute of Physics, London, 1979), pp. 144-153
4779	Annealing of Se-Implanted GaAs and InP by Scanned Nd:YAG Laser Irradiation	J. C. C. Fan J. P. Donnelly C. O. Bozler R. L. Chapman	Chapter 6 in Gallium Arsenide and Related Compounds (St. Louis) 1978 (The Institute of Physics, London, 1979), pp. 472-483
4953	The Alignment of Masks and Substrates for X-ray Lithography	D. C. Shaver D. C. Flanders	Proc. Lithography/Microscopy Beam Line Design Workshop, SSRL No. 79/02, Stanford University, 21-22 February 1979, pp. 131-142

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UNPUBLISHED REPORTS

Journal Articles

JA No.			
4895	Extended Measurement and Analysis of the ν_3 Infrared Band of Methane	D. L. Gray* A. G. Robiette* A. S. Pine	Accepted by J. Mol. Spectrosc.
4932	Electron Paramagnetic Resonance in Ferrous Fluosilicate at Submillimeter Wavelengths	R. S. Rubins* H. R. Fetterman	Accepted by J. Chem. Phys.
4934	Calculated and Measured Efficiencies of Shallow-Homojunction GaAs Solar Cells	J. C. C. Fan C. O. Bozler B. J. Palm	Accepted by Appl. Phys. Lett.
4944	Design and Development of a High-Speed Electrooptic A/D Converter	F. J. Leonberger C. E. Woodward D. L. Spears	Accepted by IEEE Trans. Circuits and Systems
4947	Solid Electrolytes Containing Both Mobile and Immobile Alkali Ions	H. Y-P. Hong	Accepted by J. Power Sources
4948	Efficient Conversion of Surface Acoustic Waves in Shallow Gratings to Bulk Plate Modes	J. Melngailis H. A. Haus* A. Lattes*	Accepted by Appl. Phys. Lett.
4963	Spectroscopy and Lasing in $K_5NdLi_2F_{10}$ (KNLF)	A. Lempicki* B. McCollum* S. R. Chinn	Accepted by IEEE J. Quantum Electron.
4966	Ionization Coefficients of Electrons and Holes in InP	C. A. Armiento S. H. Groves C. E. Hurwitz	Accepted by Appl. Phys. Lett.

*Author not at Lincoln Laboratory.

JA No.			
4978	Subtraction of Signal Overlaps in Rutherford Backscattering Spectrometry	Z. L. Liau	Accepted by Appl. Phys. Lett.
4981	A SAW/CCD Programmable Matched Filter	R. W. Ralston D. L. Smythe E. Stern	Accepted by Appl. Phys. Lett.
4989	A New Cut of Quartz for Temperature-Stable SAW Dispersive Delay Lines	D. E. Oates	Accepted by IEEE Trans. Sonics Ultrason.
5000	Replication of 175 Å Lines and Spaces in PMMA by X-Ray Lithography	D. C. Flanders	Accepted by Appl. Phys. Lett.
5005	Directional Oxygen-Ion-Beam Etching of Carbonaceous Materials	P. D. DeGraff D. C. Flanders	
5006	X-Ray Lithography at ~100 Å Linewidths Using X-Ray Masks Fabricated by Shadowing Techniques	D. C. Flanders	
5007	Spatial-Period-Division – A New Technique for Exposing Submicrometer-Linewidth Periodic and Quasi-Periodic Patterns	D. C. Flanders A. M. Hawryluk H. I. Smith	Accepted by J. Vac. Sci. Technol.
5008	Graphoepitaxy of Silicon on Fused Silica Using Surface Micropatterns and Laser Crystallization	M. W. Geis D. C. Flanders H. I. Smith D. A. Antoniadis*	
5009	X-Ray Zone Plates Fabricated Using Electron Beam X-Ray Lithography	D. C. Shaver D. C. Flanders N. M. Ceglio* H. I. Smith	

Meeting Speeches†

MS No.			
4177G	Sputtered Films for Wavelength-Selective Applications	J. C. C. Fan	1979 Spring Mtg. of American Vacuum Society, Rochester, New York, 19 June 1979
4802C	Vibrational Kinetics in Cryogenic Liquids and Applications to Nonlinear Optics	S. R. J. Brueck T. F. Deutsch H. Kildal R. M. Osgood, Jr.	NATO Advanced Study Institute, Menton, France, 25 June – 7 July 1979

*Author not at Lincoln Laboratory.

† Titles of Meeting Speeches are listed for information only. No copies are available for distribution.

MS No.			
4863	Molecular-Beam Epitaxy of IV-VI Semiconductors on IV-VI Substrates	J. N. Walpole	Molecular Beam Epitaxy Symp., Boston, 6-11 May 1979
4876	FM Mode-Locked $Nd_{0.5}LA_{0.5}P_5O_{14}$ Laser	S. R. Chinn W. K. Zwicker*	CLEA '79, Washington, D.C., 30 May – 1 June 1979
4904	Laser Initiated Deposition of Metal Films with Microscopic Dimensions	T. F. Deutsch D. J. Ehrlich R. M. Osgood, Jr.	
4905	Optically Pumped Photodissociation Lasers	D. J. Ehrlich R. M. Osgood, Jr.	
4907	Submillimeter Double Resonance Study of CH_3F Using Reradiation from Schottky Barrier Diodes	W. A. M. Blumberg H. R. Fetterman D. D. Peck P. F. Goldsmith*	
4908	Third Harmonic Generation and Infrared Kerr Switching in Cryogenic Liquids – Efficiency Limitations and Applications	H. Kildal S. R. J. Brueck	
4911	Frequency and Spatial Hole-Burning Properties of $Ga_xAl_{1-x}As$ External-Cavity Diode Lasers	M. W. Fleming A. Mooradian	
4912	Continuously Tunable cw $Ni:MgF_2$ Laser	P. F. Moulton A. Mooradian	
5033	UV Solid-State Ce:YLF Laser at 325.5 nm	D. J. Ehrlich P. F. Moulton R. M. Osgood, Jr.	
5047	Efficient Infrared ac Kerr Switches Using Simple Cryogenic Liquids	S. R. J. Brueck H. Kildal	
4878B	Liquid-Phase Epitaxy of $Hg_{1-x}Cd_xTe$	T. C. Harman	21st Electronic Materials Conf., University of Colorado, Boulder, 27-29 June 1979
4904A	Laser Photodeposition of Films with Micrometer Size Features	D. J. Ehrlich T. F. Deutsch R. M. Osgood, Jr.	
4988	Growth Rates, Morphology, and Doping of CVD GaAs Epilayers on Polycrystalline GaAs Substrates	R. P. Gale F. M. Davis J. C. C. Fan C. O. Bozler	

*Author not at Lincoln Laboratory.

MS No.			
4995	Laser Crystallization of Thin Amorphous Germanium Films	J. C. C. Fan R. L. Chapman R. P. Gale H. J. Zeiger	21st Electronic Materials Conf., University of Colorado, Boulder, 27-29 June 1979
4883C	Solar Photovoltaic Cells	J. C. C. Fan	New England Chapter of American Chemical Society, Woburn, Massachusetts, 21 June 1979
4905B	Stimulated Optical Phenomena in Photodissociation Lasers	D. J. Ehrlich R. M. Osgood, Jr.	1979 Gordon Research Conference, Wolfeboro, New Hampshire, 2-6 July 1979
5047B	Third-Order Nonlinear Coefficients of Cryogenic Liquids	H. Kildal S. R. J. Brueck	
4949	Effect of Pressure and Composition on Fast Na^+-Ion Transport in the System $Na_{1+x}Zr_2Si_xP_{3-x}O_{12}$	J. A. Kafalas R. J. Cava*	Intl. Conf. on Fast Ion Transport in Solids, Lake Geneva, Wisconsin, 21-25 May 1979
4986	Crystal Structure and Ionic Conductivity of a New Superionic Conductor, $Na_3Sc_2P_3O_{12}$	H. Y-P. Hong	
4996	Analysis of the Alternating Current Properties of LISICON Ceramics	M. L. Bayard	
4952	Ion-Implanted, Laser-Annealed GaAs Solar Cells	J. C. C. Fan R. L. Chapman J. P. Donnelly G. W. Turner C. O. Bozler	37th Annual Device Research Conf., University of Colorado, Boulder, 25-27 June 1979
4960	High-Speed InP Optoelectronic Switch	F. J. Leonberger P. F. Moulton	
4993	Ionization Coefficients of Electrons and Holes in InP	C. A. Armiento S. H. Groves C. E. Hurwitz	
4994	Guarded Avalanche Photodiodes in InP Fabricated by a Double Ion Implantation Technique	J. P. Donnelly V. Diadiuk C. A. Armiento S. H. Groves G. W. Iseler	
5044	1.0-1.6 μm Sources and Detectors for Fiber Optics Applications	A. G. Foyt	
4959	Surface-Acoustic-Wave Convolvers for Processing Spread-Spectrum Signals	R. C. Williamson	Natl. Radio Science Mtg., University of Washington, Seattle, 18-22 June 1979

*Author not at Lincoln Laboratory.

MS No.			
4965	Doppler-Limited Spectroscopy of the $3\nu_3$ Band of SF_6	A. S. Pine	34th Annual Symp. on Molecular Spectroscopy, Ohio State University, 11-15 June 1979
5055	Deconvolving Infrared Spectra Beyond the Doppler Limit	J. Pliva* A. S. Pine	
4966	Spatial Period Division – A New Technique for Fabricating Gratings	D. C. Flanders A. M. Hawryluk H. I. Smith	
4967	Micromorphotaxy of Silicon on Fused Silica Using Surface Micropatterns and Laser Crystallization	M. W. Geis D. C. Flanders H. I. Smith	
4968	X-ray Zone Plates Fabricated Using Electron-Beam and X-ray Lithography	D. C. Shaver D. C. Flanders N. M. Ceglio* H. I. Smith	Electron, Ion and Photon Beam Technology Symp., Boston, 29 May – 1 June 1979
4976	X-ray Lithography at ~100 Å Linewidths Using X-ray Masks Fabricated by Shadowing Techniques	D. C. Flanders	
5043	Directional Oxygen-Ion-Beam Etching of Carbonaceous Materials	P. D. DeGraff D. C. Flanders	
4974	Infrared Electroluminescence as a Diagnostic Tool for Polycrystalline GaAs Solar Cells	G. W. Turner J. C. C. Fan J. P. Salerno	Photovoltaic Material and Device Measurements Workshop, Arlington, Virginia, 11-13 June 1979
5013	Four-Wave Interactions in Acoustoelectric Integrating Correlators	R. W. Ralston	Boston Section IEEE, Raytheon Co., Bedford, Massachusetts, 23 May 1979
5023	Excited State Spectroscopy and Kinetics of CH_3F Using Tunable Submillimeter Sources	W. A. M. Blumberg H. R. Fetterman D. D. Peck P. E. Tannenwald	Microwave Spectroscopy and Coherent Radiation Symp., Duke University, Durham, No. Carolina, 18-20 June 1979
5024	Tunable Diode Lasers and Their Spectroscopic Applications	A. Mooradian	Vavilov Conference on Lasers, Novosibirsk, USSR, 20-23 June 1979
5027	Shallow-Homojunction GaAs Solar Cells	J. C. C. Fan	3rd High Efficiency Solar Cell Mtg., Cleveland, Ohio, 13-14 June 1979
5028	Tunable Transition-Metal Doped Solid State Lasers	P. F. Moulton A. Mooradian	4th Intl. Conf. on Laser Spectroscopy, Tegernsee, Germany, 11-15 June 1979
5029	Metal-Atom Photodissociation Lasers	D. J. Ehrlich R. M. Osgood, Jr.	

* Author not at Lincoln Laboratory.

MS No.			
5032	Development and Preliminary Operation of a 5 and 10 μm DIAL System	P. L. Kelley D. Killinger N. Menyuk A. Mooradian P. F. Moulton W. E. DeFeo	9th Intl. Laser Radar Conf. on Laser Atmospheric Studies, Munich, Germany, 2-5 July 1979
5038	Electrooptical Device Development at Lincoln Laboratory	A. G. Foyt	Seminar, Aerospace Corp., Los Angeles, 9 May 1979
5048	The Interaction of CO with ZnO	R. R. Gay E. I. Solomon* V. E. Henrich* H. J. Zeiger	39th Physical Electronics Conf., University of Maryland, College Park, 18-20 June 1979
5050	Comparison of Surface-Acoustic-Wave and Optical Signal Processing	R. C. Williamson	SPIE Electro-Optical Technical Symp. and Workshop, Huntsville, Alabama, 22-25 May 1979
5084	Surface-Wave Devices for Analog Signal Processing	S. A. Reible R. C. Williamson	Seminar, University of Wisconsin, 28 June 1979
5089	Reliability and Performance of Long Wavelength, Quaternary-Based Lasers	J. N. Walpole	Gordon Research Conference on Point and Line Defects in Semiconductors, Kimball Union Academy, Meriden, New Hampshire, 25 July 1979

*Author not at Lincoln Laboratory.

SOLID STATE
DIVISION 8

I. SOLID STATE DEVICE RESEARCH

Ohmic contacts on p-InP with average specific contact resistances as low as 5×10^{-5} Ω-cm^2 have been obtained by using a combination of Q-switched laser annealing, ion implantation, and evaporated Au without microalloying. These unusually low contact resistances are important for many semiconductor devices, including diode lasers, which require minimum resistance heating for high efficiency and reliability.

As a first step in the development of high-speed guided-wave electrooptic A/D converters, Ti-diffused $LiNbO_3$ directional couplers, branching waveguides, and electrooptic interferometric modulators were successfully fabricated and tested. The interferometric modulators had a 17-dB extinction ratio and exhibited better performance for this type of device than has been reported previously.

II. QUANTUM ELECTRONICS

Single-ended remote sensing measurements of the atmospheric concentration of CO have been made out to a distance of 2.5 km using differential absorption of line-tunable, frequency-doubled CO_2-laser radiation. Diurnal variations of CO concentration in the range from 0.15 to 1 ppm were seen over a 500-m path.

CW operation of a Co:MgF_2 laser has been achieved for the first time, and continuous tuning over a 1300-cm^{-1} range from 1.63 to 2.08 μm has been demonstrated. In two different experiments, a Ni:MgF_2 laser has been operated on a single frequency with 20 mW of output power and has been Q-switched to yield 140 W of peak power, with an output-energy-density extraction of 1 J/cm^3.

The effect of etalon frequency selectivity on homogeneously broadened mode-locked lasers in the limit of low finesse and narrow free spectral range has been calculated. The etalon does not affect the mode-locked pulse width, but modulates the frequency spectrum and causes small secondary pulses. Significant perturbation occurs when the etalon discrimination is one to two orders of magnitude less than the depth of mode-locking modulation.

By using a stable, single-mode, tunable external-cavity semiconductor laser, the effects of spectral and spatial gain hole burning on the laser spectrum have been investigated. In addition, this laser has been mode-locked using microwave injection modulation.

Visible laser action on atomic transitions of Ga, In, Al, and Bi has been obtained by using an ArF excimer laser to photodissociate vapors of the corresponding metal tri-iodides. An output energy of 0.24 mJ at 417.2 nm and an energy efficiency of 2.9 percent have been obtained with Ga.

Experiments with UV photodeposition of metals have shown the efficacy of a buffer-gas additive in localizing the deposition process. In addition, the deposition rate has been measured and shown to increase linearly with laser fluence and the absorption coefficient of the parent gas.

The infrared-submillimeter double-resonance experiment, which uses the generation and detection of tunable submillimeter radiation in Schottky-diode mixers, has been extended to pulsed measurements. This has permitted observations of rapid time-dependent phenomena in vibrationally excited CH_3F.

III. MATERIALS RESEARCH

As a step in the development of technology for producing efficient GaAs solar cells on low-cost substrates, the chemical vapor deposition of GaAs epitaxial layers on large-grained GaAs substrates has been investigated in order to determine the dependence of growth rate, surface morphology, and impurity doping on crystallographic orientation. Variations in surface topography from grain-to-grain can be minimized by adjusting the growth parameters, and variations in doping with Zn or S are small enough to be compatible with present techniques for fabricating shallow-homojunction GaAs cells on single-crystal substrates.

Shallow-homojunction GaAs solar cells have been found to exhibit superior resistance to 1-MeV electron radiation, indicating that such cells would be very resistant to the radiation of the space environment. By optimizing device design and fabrication procedure, it should therefore be possible to produce cells of this type as efficient power sources with long operating lifetimes for space applications.

IV. MICROELECTRONICS

A DC measurement technique has been developed to aid in the 100-percent inspection of chromium-on-glass photolithographic masks. These measurements detect the presence of chromium bridges between adjacent lines on masks used to define the metallization on the device. After the existence of a bridging defect has been detected, microscopic examination is used to locate the defect, and laser vaporization or spot etching is used to eliminate it.

Electrical activation of ion implants by laser annealing has been shown to be a tool for wafer rework at advanced stages of wafer fabrication in situations where conventional thermal processes are not possible. By using this technique, an ohmic contact has been fabricated to the back side of a wafer of commercially obtained, 512-stage, binary-reference, analog CCD correlator chips. These devices were difficult to test functionally as received, but the addition of the back-side ohmic contact allowed operation suitable for preliminary testing.

MgO/Au cermet films have been used to form integrated light shields to prevent illumination of the output register and detection circuitry of the CCD imaging devices being fabricated for the GEODSS (Ground Electro-Optical Deep Space Surveillance) Program. The MgO/Au films satisfy all the requirements for this light shield because of their high optical absorption, high resistivity, and ease of deposition and pattern definition.

V. ANALOG DEVICE TECHNOLOGY

Nearly 100-percent conversion of surface acoustic waves to bulk-plate modes via normal-incidence gratings has been observed for surface waves of wavelength near the grating period. For a crystal with gratings on opposite faces, a surface wave on one face is efficiently coupled to a surface wave on the opposite face. A theory has been developed that can predict the transmission coefficients and the selected frequencies at which efficient conversion occurs.

Techniques for fabricating Josephson-junction devices have been developed. The basic junction structure consists of a niobium base electrode, a niobium oxide tunnel barrier, and a lead counterelectrode. A normal metal, aluminum, or an indium-gold alloy is employed in thin-film resistors.

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